

IN THE SPECIFICATION

**Please amend the paragraph beginning at page 5, line 15, as follows:**

(1) A method of manufacturing a porous thick film as an oxygen partial pressure detecting part of a resistive oxygen sensor comprising taking a fine particle powder of an oxide containing cerium oxide as a raw material powder, preparing a paste containing the oxide, printing the paste onto a substrate by screen printing, calcining and sintering, the method comprising: a heat treatment step of carrying out heat treatment to ~~effect affect~~ particle growth from the average particle diameter of the raw material powder to a particle diameter less than the average particle diameter of the ultimately obtained thick film; a step of mixing the particle ~~growth-effected~~ growth-affected powder with a solvent; a step of dispersing agglomerated particles in the solvent; a step of removing a precipitate; a step of evaporating off the solvent; and a step of mixing the resulting oxide with an organic binder to obtain the paste.

**Please amend the paragraph beginning at page 6, line 6, as follows:**

(3) The method according to (1) above, wherein the average particle diameter of the particle ~~growth-effected~~ growth-affected powder obtained through the heat treatment step is at least 45 nm.

**Please amend the paragraph beginning at page 7, line 2, as follows:**

A flowchart of a manufacturing method of the present invention is shown in FIG. 1. In the present invention, cerium oxide, or an oxide having cerium oxide as a principal component thereof is used as a raw material. Specifically, an ‘oxide having cerium oxide as a principal component thereof’ is, for example, an oxide having cerium oxide as a principal component thereof and containing zirconium oxide, titanium oxide, germanium oxide,

hafnium oxide or the like, more preferably an oxide having cerium oxide as a principal component thereof and containing zirconium oxide. In the case that the secondary component is more abundant than the cerium oxide, the properties of the powder will be greatly different to those of cerium oxide, and hence it is preferable for the secondary component concentration to be not more than 40 mol%. Moreover, the fine particles of the raw material preferably have an average particle diameter of 10 to 20 nm, with it being acceptable for there to be a spread of particle diameters. The method of the present invention can be suitably applied to a powder of an oxide as described above comprising fine particles having a low particle diameter (less than 40 nm) that readily agglomerate. Examples of methods of manufacturing such oxide fine particles include, for example, a precipitation method, a coprecipitation method, and a hydrothermal synthesis method. With the precipitation method or coprecipitation method, a precipitate containing a hydroxide, water and so on is heated in air, whereby an oxide powder can be obtained. In the case of cerium oxide, the oxide can be obtained upon heating at a temperature of 600°C. The heat treatment step for changing the precipitate containing the hydroxide, water and so on into the oxide, and a heat treatment step for ~~effecting~~ affecting particle growth of the present invention can thus be carried out consecutively.

**Please amend the paragraph beginning at page 8, line 5, as follows:**

With the present invention, first, to ~~effect~~ affect particle growth to a particle diameter less than the average particle diameter of the thick film to be ultimately obtained, a raw material powder as described above is subjected to heat treatment in a heat treatment step; this is because if particle growth is not ~~effected~~ affected, then cracks will arise in the thick film after the sintering step described later (see Example 1 and Comparative Example 2). Moreover, the reason for making the particle diameter to which the particle growth is ~~effected~~

affected be less than the average particle diameter of the thick film to be ultimately obtained is that it is not possible to reduce the particle diameter in the final sintering step. The temperature in the heat treatment step is preferably at least 800°C, this being because at a lower temperature particle growth will not occur. Furthermore, in the case that the average particle diameter of the thick film ultimately obtained is made to be, for example, 100 nm, the temperature in the heat treatment step is preferably 880 to 920°C. This is because with sintering at approximately 950°C or more, particle growth will occur to a particle diameter exceeding 100 nm (see Example 2), and hence it will be impossible to make the average particle diameter of the thick film ultimately obtained be not more than 100 nm.

**Please amend the paragraph beginning at page 8, line 26, as follows:**

In general, the temperature in the heat treatment of the powder is set to be lower than the sintering temperature in the sintering carried out after the screen printing. Consequently, in the case of making the average particle diameter of the thick film ultimately obtained be, for example, 100 nm, it is sufficient if the particle diameter to which the particle growth is effected affected in the heat treatment step is at least 45 nm. As shown in Example 1 described later, in the case that the average particle diameter of the particle ~~growth~~ affected growth-affected powder is 48 nm, a porous thick film having extremely few cracks is obtained. It is obvious that even in the case of a particle diameter higher than this, a porous thick film having no cracks can be obtained, and hence if the particle diameter to which the particle growth is effected affected in the heat treatment step is at least 45 nm, then a porous thick film having extremely few cracks can be obtained. Next, a solvent is added to the raw material oxide; the solvent is preferably an organic solvent that has a low viscosity and is easily evaporated such as ethanol or toluene. This is because a solvent that can be easily evaporated in the subsequent step of reducing the amount of the solvent is preferable. Next,

the oxide is treated in the solvent using an ultrasonic homogenizer or the like, thus dispersing agglomerated particles. A powder obtained by the precipitation method or coprecipitation method is characterized in that the fine particles are agglomerated. If the powder is made into a paste while the particles are still agglomerated, then the thick film ultimately obtained will be extremely bumpy, and hence will not readily stick to an electrode or the like. Moreover, agglomerated particles are a cause of cracks arising. It is thus necessary to disperse agglomerated particles. Moreover, even if the particles were not agglomerated before the heat treatment, the particles will agglomerate through the heat treatment in the heat treatment step described above, and hence this dispersion step is always required.

**Please amend the paragraph beginning at page 11, line 20, as follows:**

In the heat treatment step described earlier, the particle diameter of the powder is made to grow through the heat treatment; as described earlier, if such particle growth is not effected affected, then particle growth will occur in the subsequent sintering stage, and volume shrinkage will occur accompanying this. At this time, stress must be relaxed, and it is thought that this is why cracks arise in the thick film. Alternatively, it is thought that this may be because the particle diameter is low, and hence the mixing with the organic binder becomes uneven, whereby places where the fine particles are abundant and places where the fine particles are sparse arise. In any case, to prevent such cracking, it is necessary to effect affect particle growth in advance. Next, in the step of dispersing agglomerated particles described earlier, particles that have agglomerated in the solvent are dispersed; in the case that the particle diameter of the fine particles is low, even in the case of particles having no agglomeration at the raw material stage, agglomeration arises upon effecting affecting particle growth in the heat treatment step, and hence this dispersion step is required.

**Please amend the paragraph beginning at page 20, line 3, as follows:**

Example 3

In the present example, a powder was prepared using the following procedure. First, a cerium nitrate aqueous solution was prepared. Next, ammonia water was added, whereby a precipitate was produced. This precipitate was mixed with carbon, and heated for 4 hours at 900° in air, thus obtaining the powder. In this heat treatment step, the heat treatment step for changing the precipitate containing the hydroxide, water and so on into the oxide and the heat treatment step for effecting affecting particle growth were carried out consecutively. The powder was then mixed with ethanol, and then a thick film was manufactured using the same method as in Example 1. The wt% of the oxide contained in the paste was made to be 20 wt%. The porous thick film manufactured in this way contained hardly any cracks, and hence it was found even if the heat treatment step for changing the precipitate containing the hydroxide, water and so on into the oxide and the heat treatment step for effecting affecting particle growth are carried out consecutively, the same effects are obtained.

**Please amend the paragraph beginning at page 20, line 22, as follows:**

Example 4

A cerium nitrate aqueous solution and a zirconium oxynitrate aqueous solution were mixed together in a Ce:Zr ratio of 8:2, thus obtaining a mixed aqueous solution. Ammonia water was added to this mixed aqueous solution, thus bringing about coprecipitation. Next, the precipitate was mixed with carbon, and heated for 4 hours at 900°C in air, whereby heat treatment for changing the precipitate containing a hydroxide, water and so on into an oxide, and the heat treatment step for effecting affecting particle growth were carried out consecutively. In this way, a powder of cerium oxide containing 20 mol% of zirconium

oxide was obtained. This was mixed with ethanol, and then thick films were manufactured using the same method as in Example 1. The wt% of the oxide contained in the paste was made to be 10 or 20 wt%. The cerium oxide porous thick films containing 10 mol% of zirconium oxide manufactured in this way were checked using SEM photomicrography, whereupon it was found that hardly any cracks were contained; even at 20 mol%, it was found that there were few cracks, and hence it was found that the present invention can also be applied to cerium oxide containing zirconium oxide.

**Please amend the paragraph beginning at page 21, line 16, as follows:**

Industrial Applicability

As described in detail above, the present invention relates to a method of manufacturing a porous thick film as an oxygen partial pressure detecting part of a resistive oxygen sensor. According to the present invention, the following remarkable ~~effects~~ affects are produced: 1) taking as a raw material a powder comprising fine particles of cerium oxide or an oxide having cerium oxide as a principal component thereof manufactured using a precipitation method enabling mass production, there can be manufactured a porous thick film of cerium oxide or an oxide having cerium oxide as a principal component thereof that has extremely few cracks, has an average particle diameter of not more than 200 nm, and can be satisfactorily used as an oxygen partial pressure detecting part of an oxygen sensor; 2) with a conventional method, in the case of using as a raw material a powder comprising fine particles that have a low particle diameter (less than 40 nm) and thus readily agglomerate, a porous thick film having few cracks could not be manufactured, but according to the method of the present invention, a porous thick film having few cracks can be manufactured even if such a raw material is used; 3) because the average particle diameter of the porous thick film

Application No. 10/540,873  
Reply to Office Action of July 25, 2008

obtained using the manufacturing method of the present invention is not more than 200 nm, a resistive oxygen sensor having an excellent response speed can be obtained.

**Please replace the Abstract in its entirety and substitute the new Abstract shown on the following page:**